POWERHEAD

Section 4B - Cooling

Table of Contents

Specifications

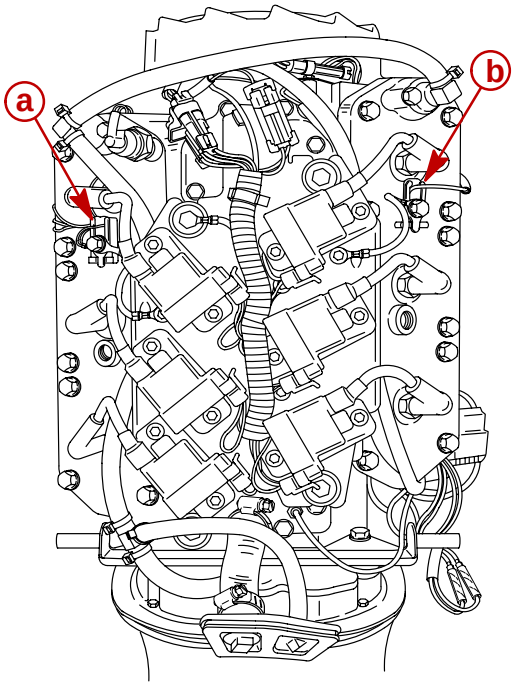
Thermostat . . . . . 143°F (61.7°C)

Water Pressure

Idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)
Poppet Valve Opening	4 – 9 PSI (27.4 – 61.6 kPa)
W.O.T.	12.0 PSI (82.1 kPa) Minimum

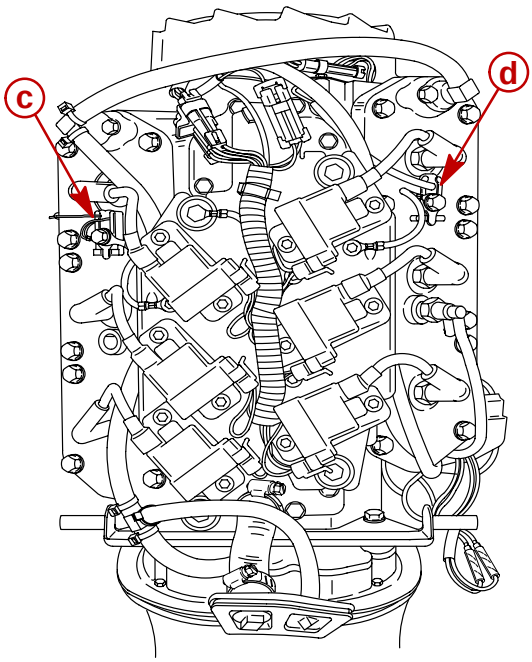
Temperature Sensor

Temperature Sensor(s)	
Between Black and each TAN/BLK wire.	No Continuity
Between each lead and ground	No Continuity



a - Temperature Sensor (EFI Models) and optional gauge sender

b - Temperature Sensor for Warning Horn (EFI Models)

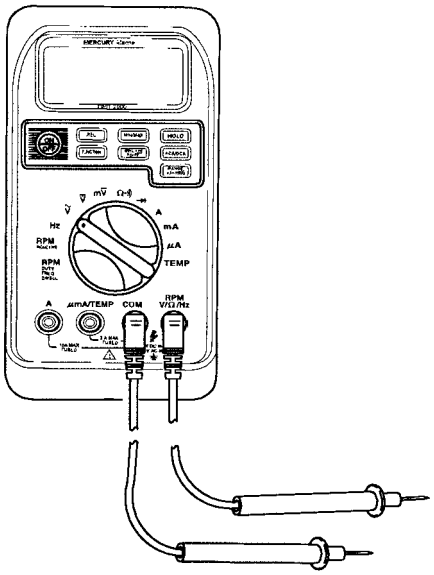


c - Temperature Sensor for optional gauge (Carb Models)

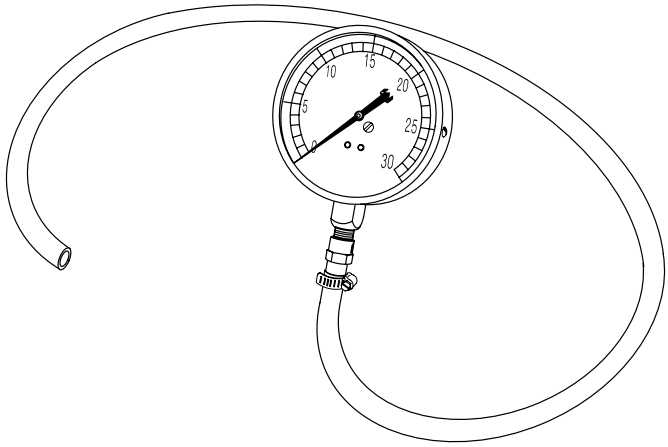
d - Temperature Sensor for Warning Horn (Carb Models)

Special Tools

1. DMT 2000 Digital Tachometer Multimeter P/N 91-854009A1



2. Water Pressure Gauge 91-79250A2



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Temperature Sensor

EFI Models – Sensor (in port cylinder head) provides the ECM signals related to engine temperature to determine the level of fuel enrichment during engine warm up. The ECM receives information at all engine temperatures but stops fuel enrichment when engine temperature reaches 90° F (32° C). An open circuit on the temperature sensor will increase fuel flow up to 40% but will not affect fuel flow at wide open throttle. If no change occurs when sensor is disconnected, sensor may not be functioning properly.

NOTE: TAN/BLUE sensor lead (in port temperature sensor) provides signal for optional temperature gauge.

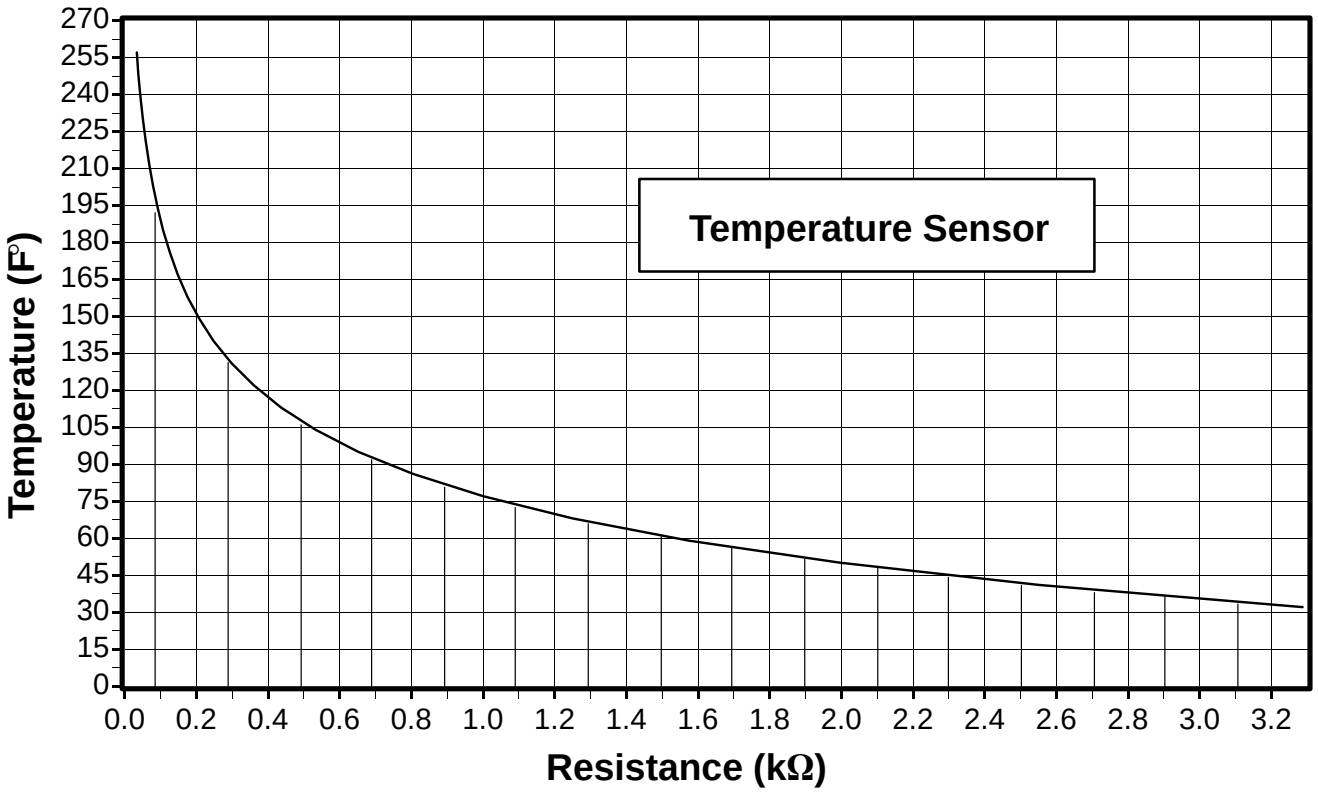
NOTE: If sensor does not make clean contact with cylinder head, a rich fuel condition may exist.

NOTE: The Digital Diagnostic Terminal (DDT) can be used to monitor temperature readings from both air and head temperature sensors.

NOTE: Temperature sensor in starboard cylinder head on EFI models activates a warning horn when engine temperature exceeds 240° F ± 8° F (115.6°C ± –13.3°C). Warning horn will deactivate when engine temperature drops below 210° F ± 15° F (98.9°C ± –9.4°C).

An ohms test of the temperature sensor (in port cylinder head) would be as follows:

Insert digital or analog ohmmeter test leads into both TAN/BLACK sensor leads. With engine at temperature (F°) indicated, ohm readings should be as indicated ±10%.



Carburetor Models – Temperature sensor in starboard cylinder head activates a warning horn when engine temperature exceeds 240° F ± 8° F (115.6°C ± –13.3°C). Warning horn will deactivate when engine temperature drops below 210° F ± 15° F (98.9°C ± –9.4°C).

Temperature sensor in port cylinder head provides signal for optional temperature gauge.

Water Flow

Description

Cooling water enters the cooling system through the lower unit water inlets. The pump assembly forces water through the water tube and exhaust adapter plate passages filling the power head central water chamber (located behind the exhaust cavity). Water enters the exhaust cover cavity through 2 holes near the top of the exhaust cover.

Water exits the exhaust cover cavity through 4 slots (2 each side) filling the water passages around the cylinders. Water flows around each bank of cylinders to the top of the cylinder block.

Water flow exiting the cylinder block is controlled by the thermostats (1 in each cylinder head) and the poppet valve (located at the bottom starboard side of powerhead). At low RPM (below 1500 RPM), the thermostats control water flow depending upon engine temperature. When the thermostats are open, water passes through the cylinder heads and exits to the drive shaft housing. At higher RPM (above 1500 RPM) the poppet valve will control the water flow.

Water that passes through the poppet valve enters water passages in the adaptor plates. Water passes through the adaptor plates into the driveshaft housing.

Water dumped into the drive shaft housing builds up a wall of water around the exhaust tube. This performs 2 functions:

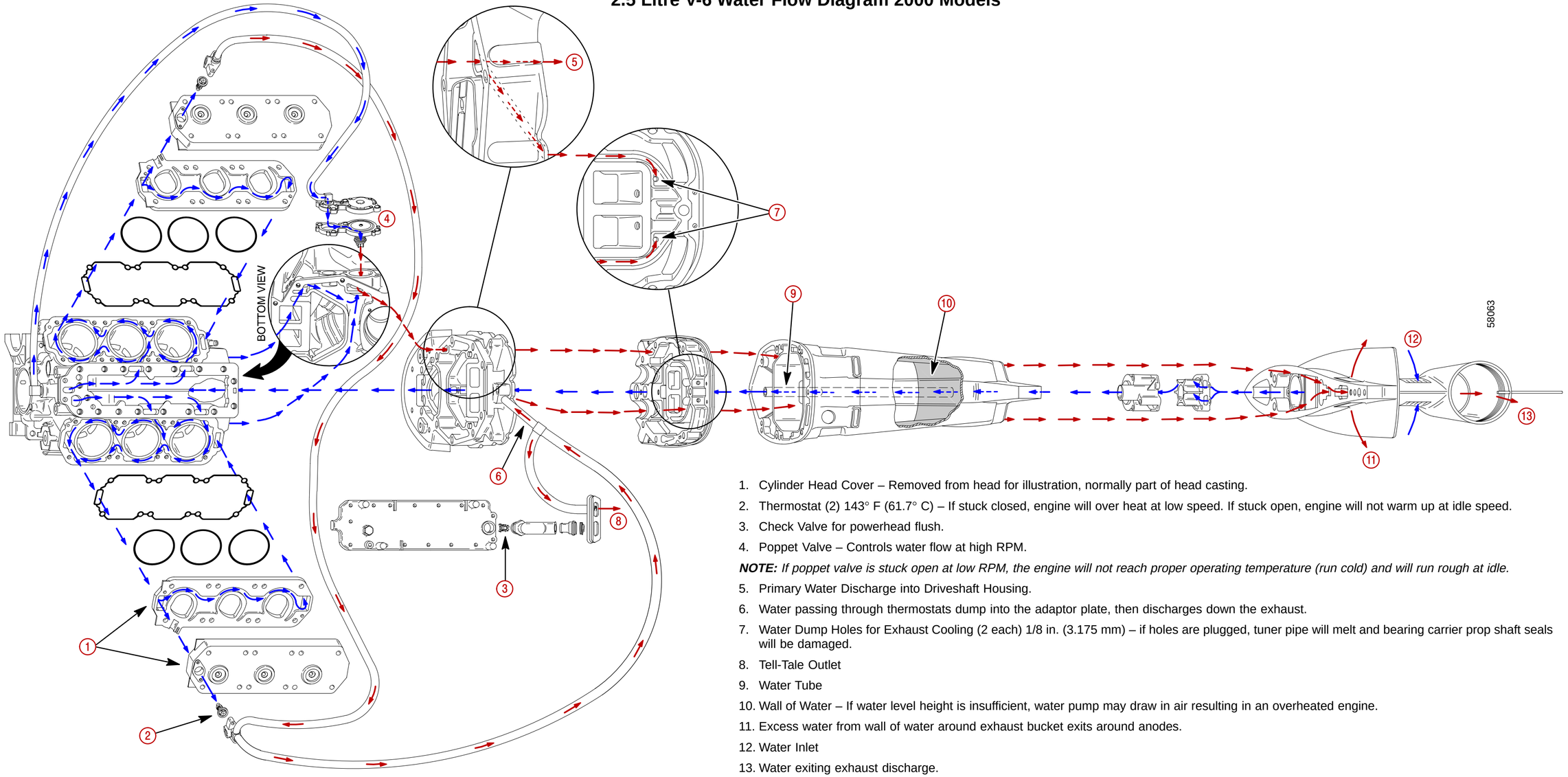
- Helps silence the exhaust
- Prevents air from being drawn into the pump

Water exits the engine in 3 locations:

- Excess water from the wall of water exits around anodes on the gear housing.
- A portion of the water that passes through the thermostats exits out the tell tail.
- Water exits through two 1/8 in. (3.175 mm) holes in the lower adaptor plate into the exhaust.

To allow complete passage filling and to prevent steam pockets, all cooling passages are interconnected. Small passages are incorporated to allow the cooling system to drain.

2.5 Litre V-6 Water Flow Diagram 2000 Models



1. Cylinder Head Cover – Removed from head for illustration, normally part of head casting.
2. Thermostat (2) 143° F (61.7° C) – If stuck closed, engine will over heat at low speed. If stuck open, engine will not warm up at idle speed.
3. Check Valve for powerhead flush.
4. Poppet Valve – Controls water flow at high RPM.

NOTE: *If poppet valve is stuck open at low RPM, the engine will not reach proper operating temperature (run cold) and will run rough at idle.*

5. Primary Water Discharge into Driveshaft Housing.
6. Water passing through thermostats dump into the adaptor plate, then discharges down the exhaust.
7. Water Dump Holes for Exhaust Cooling (2 each) 1/8 in. (3.175 mm) – if holes are plugged, tuner pipe will melt and bearing carrier prop shaft seals will be damaged.
8. Tell-Tale Outlet
9. Water Tube
10. Wall of Water – If water level height is insufficient, water pump may draw in air resulting in an overheated engine.
11. Excess water from wall of water around exhaust bucket exits around anodes.
12. Water Inlet
13. Water exiting exhaust discharge.

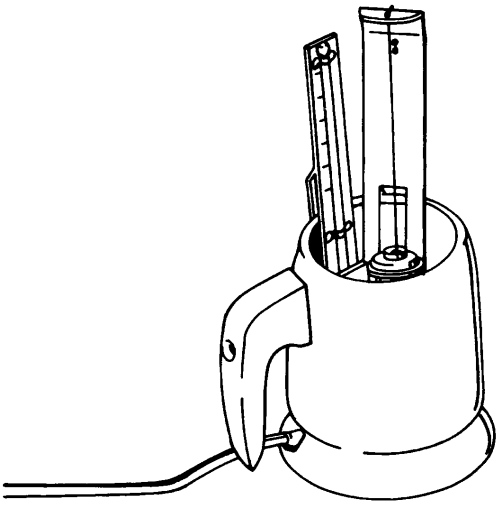
Notes:

Troubleshooting

Thermostat Test

1. Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
2. Remove and discard gasket from each thermostat.
3. Wash thermostats with clean water.
4. Using a thermostat tester, similar to the one shown, test each thermostat as follows:
   a. Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.
   b. Suspend thermostat (from thread) and thermometer inside tester so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.
   c. Fill thermostat tester with water to cover thermostat.
   d. Plug tester into electrical outlet.
   e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step “a”, when it starts to open.) Thermostat must begin to open when temperature reaches 140°-145° F (60°-63° C).
   f. Continue to heat water until thermostat is completely open.
   g. Unplug thermostat tester.
   h. Replace thermostat, if it fails to open at the specified temperature, or if it does not fully open.

NOTE: *BE SURE that water in thermostat tester is allowed to cool sufficiently [below 110° F (43.3° C)] before testing the other thermostat.*



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IMPORTANT: DO NOT operate engine without thermostats installed.

Water Pressure Check

Water pressure may be checked by attaching a test pressure gauge to the top of the engine block.

A water pressure line (GRAY colored) is provided that exits at the front of the lower cowl. A dash style gauge may be connected to this line to register water pressure.

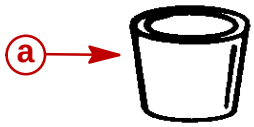
⚠ WARNING

Shut off engine and refer to troubleshooting chart if water pressure is not within specification. DO NOT exceed 3000 RPM in neutral.

Idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)
Poppet Valve Opening	4 – 9 PSI (27.4 – 61.6 kPa)
W.O.T.	12.0 PSI (82.1 kPa) Minimum

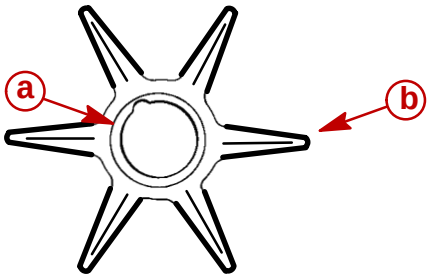
Water Pump Cleaning and Inspection

1. Inspect the water tube coupling for wear or damage. If necessary replace..



a - Water Tube Coupling

2. Inspect the water pump impeller for wear on the end, top and bottom of the impeller blades. Replace the impeller if this condition is found.
3. Inspect for proper bonding between the hub and the impeller. Replace the impeller if improper bonding is found.

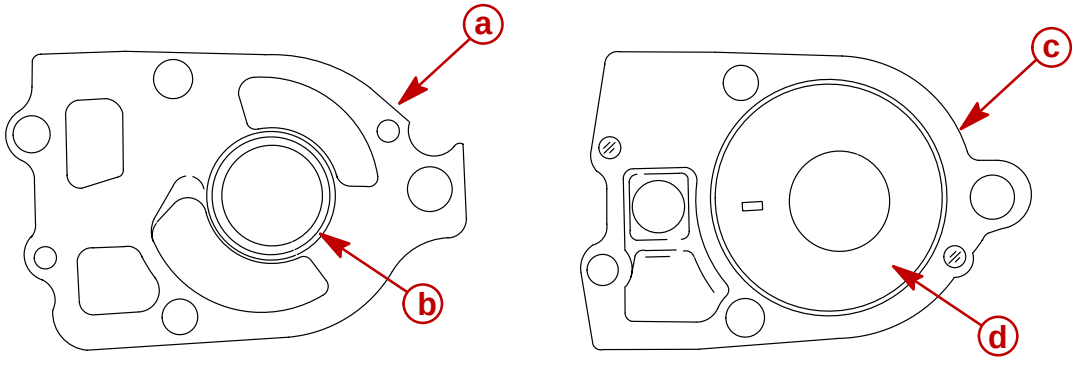


a - Hub
b - Impeller

4. Inspect the impeller blades to see if they are cracked, burnt, hard or deformed. Replace the impeller if the blades are in this condition.

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate. The depth of the groove will not affect water pump output.

5. Replace cover if plastic is melted from excessive heat (lack of water). Replace stainless insert and/or face plate if grooves (other than impeller sealing bead groove) are more than 0.010 in. (0.254 mm) deep.



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a - Water Pump Face Plate
b - Sealing Groove (disregard)
c - Water Pump Cover
d - Stainless Insert [discard if grooves exceed 0.010 in. (0.254 mm)]

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

IMPORTANT: It is recommended that the water pump impeller be replaced whenever the gearcase is removed for maintenance. However, if it is necessary to re-use the impeller, DO NOT install in reverse to original rotation as premature impeller failure will occur.

Problem Diagnosis

Condition	Recommended Range	Possible Cause
Pressure below specification @ idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)	•Poppet valve spring defective (weak, broken, missing) •Defective poppet valve seal •Thermostat stuck open •Severe internal leak •Low output water pump •Inlet restriction
Pressure above 5 psi (34.2kPa) @ idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)	•Plugged poppet by-pass passage or tell-tale
Pressure does not drop between 1000 – 2500 RPM indicating poppet valve has opened	4 – 9 PSI (27.4 – 61.6 kPa) between 1000 – 2200 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Poppet valve vent hole plugged or restricted •Severe internal leak •Defective poppet valve seal
Poppet valve flutter/water pressure drop does not stabilize prior to 2500 RPM	4 – 9 PSI (27.4 – 61.6 kPa) between 1000 – 2200 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Broken diaphragm in poppet valve •Severe internal leak •Defective poppet valve seal
Pressure is below minimum specification @ W.O.T.	12 PSI (54.9 – 68.5kPa)	•Inlet restriction •Engine mounted too high on transom •Engine trimmed out too far •Configuration of boat bottom interfering with adequate flow of water to coolant inlets •Severe internal leak •Low output water pump
Pressure higher than normal @ W.O.T., but engine still indicates overheat condition	Maximum pressure – 23 PSI (157.4 kPa)	•Outlet water passages restricted. •Steam pocket has formed at top of powerhead due to lack of cooling water